Geographic Crime Information Reporting System: Crime Mapping and Analysis

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Submitted: October 30, 2013 Accepted: November 10, 2013

ABSTRACT

The primary goal of this study is to successfully develop a Geographic Crime Information Reporting System at a station in Mandaue City, an electronic blotter that uses Geographical Information System (GIS) in recording crime information. The "Geographic Crime Information Reporting System" contains a Geo Spatial Crime Visualization module that loads and displays the maps from shape files. The Crime Management Module to assign coordinates in the map given by the user to be stored in a Database. The Geographic Crime Information Analyzer analyzes the data and creates a report which is a list of possible suspects. The system is then evaluated by randomly selected Philippine National Police Officers (PNP Officer) and Philippine National Police Information Technology personnel (PNP IT Personnel) of Mandaue City. The Results show that 75% of the respondents are familiar with the Electronic-blotter (E-Blotter), with only 26.7% of them who are currently using it. 85% are familiar with maps and pins, with 64.7% of them who are currently using it. The PNP Officers evaluated the usefulness of the E-blotter with a mean rating of 3.25, which is interpreted as Moderately Acceptable. And to the usefulness of the maps and pins with a mean rating of 3.82, which is interpreted as Very acceptable. The Response clearly showed that the proposed system is useful. The PNP officers evaluated the system interfaces ease of understanding as 3.95, which is interpreted as very acceptable. The system's provision of time efficient decision making was rated 3.9, which is interpreted as very acceptable. The system's implementation of the theories was rated 3.85, which is interpreted as very acceptable. The system's accuracy of results was rated 3.75, which is interpreted as very acceptable. The PNP officers evaluated the systems importance (include all results) with an overall rating of 3.8625 which is interpreted as very acceptable. The PNP IT personnel evaluated the system with an overall rating of 4.515 on a 5-point rating system which is interpreted as completely acceptable. Functionality had a mean rating of 4.35, which is interpreted as completely acceptable. Usability had a mean rating of 4.68. This is interpreted as completely acceptable.

Keywords: *crime mapping, crime analysis, crime information reporting system*

I. INTRODUCTION

With the presence of information technology, utilizing technology to protect and preserve life can as well improve and enhance the quality of life. Thus, the development of the Electronic Blotter System or simply the E-blotter system placed in various police stations all over the Philippines. It is an act of the Philippine Government, particularly the Philippine National Police to implement its goal for peace, order and security in the community with their course of programs and activities imbibed in their core activities. The certainty of Technology and the Philippine Government working together triggered the idea to develop the "Geographic Crime Information Reporting System" (GCIRS).

Technology has been a major player in diverse aspect of human existence, particularly in this age of rapid changes and development. The utilization of information technology became a part and parcel of everyday life – with technology working hand in hand to improve and enhance the quality of life, it is as well imperative to utilize it in protecting and preserving life (Johnson, 2000).

The Philippine Government, particularly the Philippine National Police extended its arm to the full implementation of its goal of peace, order and security in the community with their various and diverse course of programs and activities which is imbibed in their core objectives. Thus, the development of Electronic Blotter System or simply E-Blotter was put in place in various police stations all over the Philippines. With the new system, information or citizen's complaint will be encoded directly to the computer, and the regional headquarters will automatically get a copy of the report. It will also allow officials to monitor police responses and development in a case, at the same time provide real-time crime data to field commanders that will eventually guide them in their crime prevention efforts (Guzman, 2012).

The utilization of Technology in the government or otherwise termed as e-government is one of the agenda or mandate of the President to provide better and faster service (Arceo-Dumlao, 2012). The reality of Technology and the Philippine Government working hand in hand triggered the idea to develop the "Geographic Crime Information Reporting System" (GCIRS). Geographic Crime Information Reporting System is an electronic blotter that uses Geographical Information System (GIS) in recording crime information. A tool that is used by many countries to fight, prevent and reduce crime rate.

The Research focuses in police stations from Mandaue City as a pilot study and is focused in areas where criminal activities are more apparent and prevalent. The system is designed in aiding police officers to narrow down or identifying probable suspects based on blottered crime information, identified by the Philippine National Police (PNP) from the logbooks which contains Blotter info. Types of crimes are also limited to crimes against property and person.

II. THEORETICAL FRAMEWORK

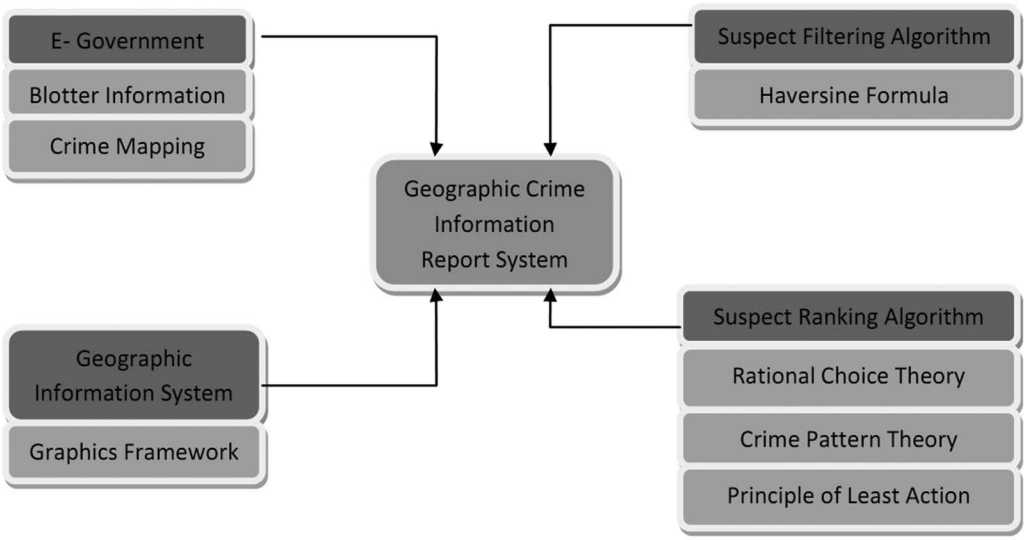
The idea of Geographic Crime Information Reporting System (GCIRS) was formulated by the following four (4) key concepts:

(i) E-Government drive of the Philippines to utilize and maximize the use of technology, PNP in particular can use it to better Serve and Protect, Blotter information that is available in various PNP Regional Offices, Crime Mapping has been a proven tool to prevent, reduce and fight criminal activities, thus integrating it in the study becomes a necessity (Johnson, 2000),

(ii) Geographic Information System (GIS), with its diverse utilization and usefulness it was included as a major part of the study for geo-spatial visualization of crimes (easier analysis and decision making), and The inclusion of a graphic framework such as DotSpatial is an important factor in the study – in here it will be able to put grids and points on the map and connects it to the database. As a whole, the idea of GCIRS is a combination of unique and distinct concepts that will give birth to an integrated system.

(iii) The Suspect Filtering Algorithm innovates the use of the Haversine Formula. The Haversine Formula is preferred over the

Figure 1. Theoretical Framework Diagram



Pythagorean Formula and the Law of Cosines because it is less sensitive to any round-off errors (Sinnot, 1984). The Suspect Filtering Algorithm repetitively compares the crime incidence point to a previously recorded suspect crime incidence point from the shape files, within the given radius, on the map to find the distances between them. The radius suggested by Canter and Hodge (1997) states that Serial Murder yields location data values of 0.81 miles and 0.79 miles; and according to Koksis & Irwin (1997) 0.77 miles for rape, 0.6 for Arson, and 1.5 to 0.65 miles for burglary.

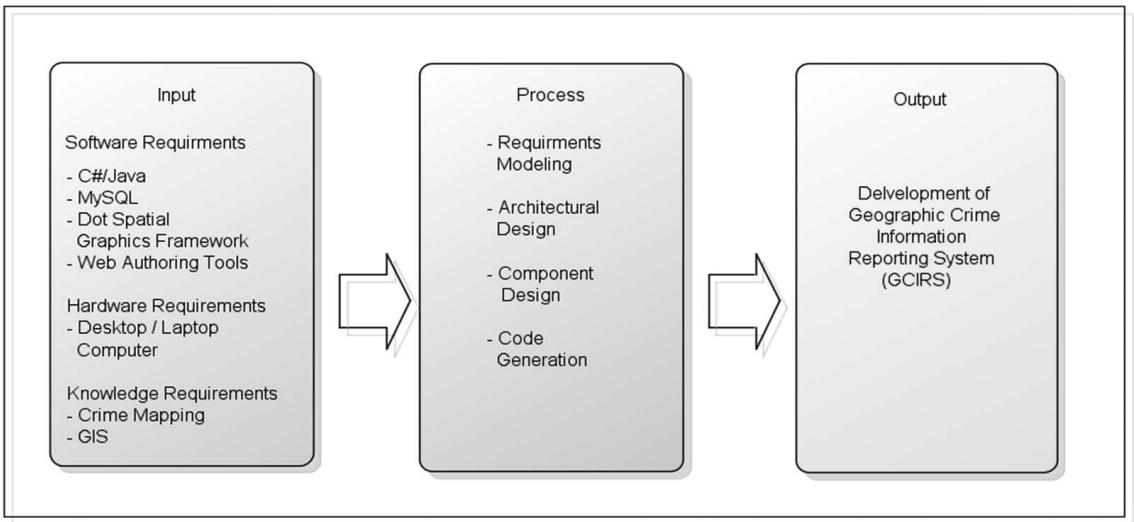
(iv) The Suspect Ranking Algorithm uses the distances found and creates a probability of suspects list. The suspect's probability of committing the crime is based on how close they are to the scene of the crime. According to the Rational Choice Theory, the existence of this buffer zone, where offenders are more likely to act on first opportunity, sees behavioral as interactional and adaptive, but rational does not equal intelligent sophistication (Cornish, 1993), is where they are likely to act on first opportunity. With the Crime Pattern Theory, D. K. Rossmo (2000) states that opportunities available to the offender are not entirely random – no matter how chaotic the crime may be, there is often a rationality based on the location of the crime incidence and there exists a kind of simulation of a structure found in its spatial distribution.

As Discussed by Keppel (1989), the targets are assessed according to their gain and risk. The targets are scanned for their visibility, unusualness and symbolism. To the offender rational choices are made to find specific targets of victimization. This process is consistent with the concept of an offender that operates within his "comfort zone", "buffer zone" or territory.

Under greater distance, the probabilities of target selection decreases (Rossmo, 2000). The Principle of Least Action pertains to the minimization of quantities within dynamic systems. It suggests that most aspects of nature follow this economy, simply because choosing to create or discover something new requires effort (Casti, 1998). People not only choose to find the most convenient and shortest path, but also to do something innovative in order to decrease cost, save time, save change (money), reduce cost, etc.

The Rational Choice Theory, Crime Pattern Theory and the Principle of Least Action are chosen for the study. Rational Choice Theory pertains to the existence of a buffer zone or comfort zone; while the Crime Pattern Theory

Figure 2. IPO Diagram of the Study



pertains to the chance of committing the crime within the buffer zone are not random; and the Principle of Least Action pertains to the relationship between the incidence of crime to the buffer zone and the probability of the suspect in committing the crime.

Figure 3. Project Design Diagram

The Suspect Ranking Algorithm was created using the assumption of the suspect's buffer zone based on the theories (Rational choice Theory, Crime Pattern Theory, and the Principle of Least Action).

The diagram above shows the Input – Process – Output Diagram of the Study. The input will be the Software, Hardware and Knowledge Requirements, while the Process contains the series of steps and activities towards the development of "Geographic Crime Information Reporting System (GCIRS)," which is the expected output of the study. Furthermore, evaluation of the study on each step is a crucial factor in ensuring that the study is hitting the mark.

III. OPERATION PROCEDURES

The Police Officer at the Police Station will have to encode the Crime Information Report (CIR) or in other words – the Crime Blotter. The CIR then will be stored in the Crimes Database Server (Station Level). The Police Station Chief will have access to the Crimes Database Server and is capable to view the Geo-Spatial Crime Visualization feature of the system which will assist in the analysis of crime activities thus give way to timely decision making.

Figure 4. System Design

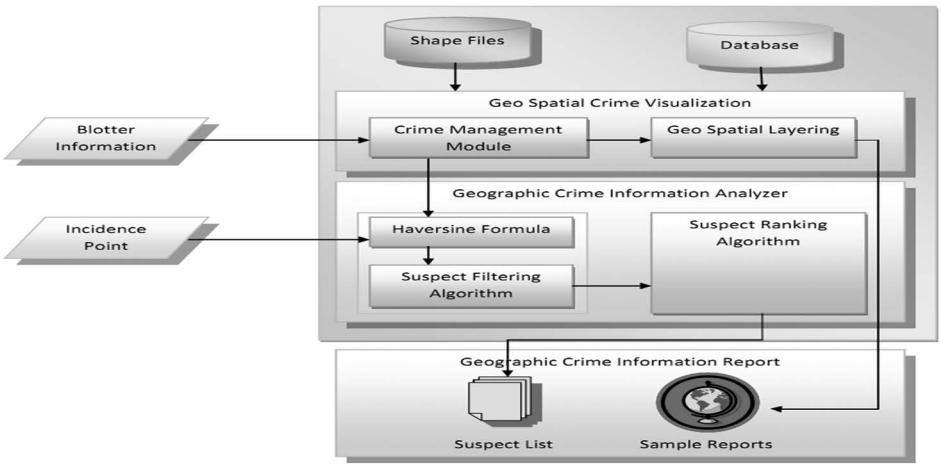
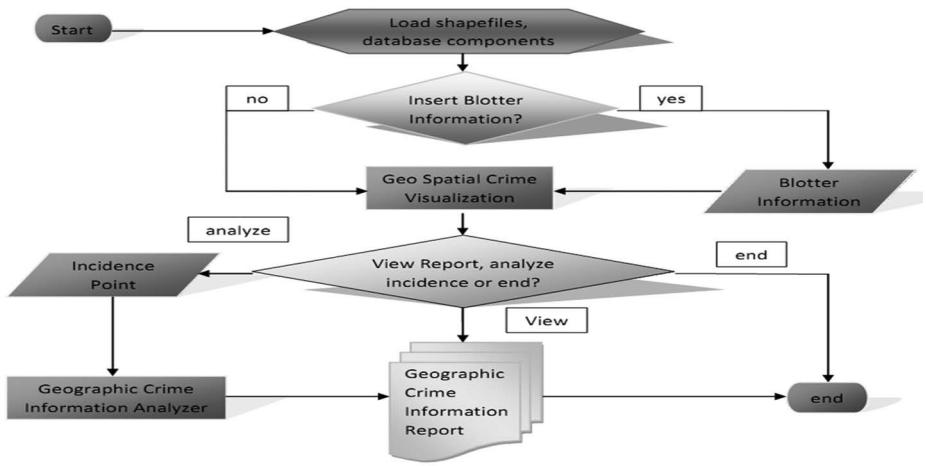


Figure 5. System Flowchart



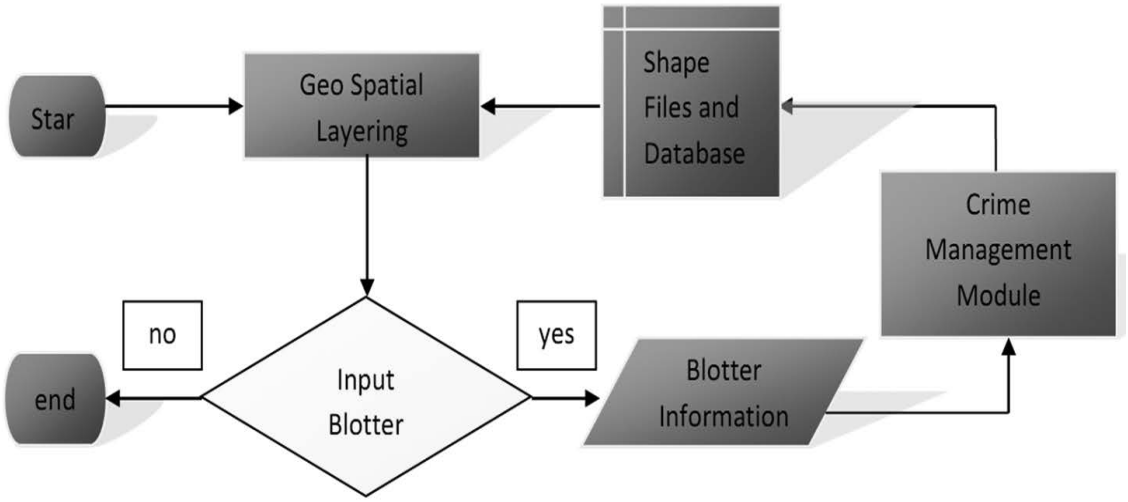
The map used in the system was the GIS of 1984. The Geo Spatial Crime Visualization module allows to read and write map data via a framework and a mapping system library. The program is then constructed on this library and framework. What this system will do is display and manipulates map data from a database and shapefiles. This program allows inputting data that is represented in points for the criminal activity and other data pertaining to the criminal. The maps that are used in this program are composed of shapefiles which contain spatial data pertaining to the area.

The Geo Spatial Crime Visualization is responsible for the displaying of maps and for inputting blotter information into the shape file and the database.

The Geographic Crime Information Analyzer module uses the point of incidence given by the user with a specific crime. A calculation is performed to find the distance between two points on the earth's surface. The result of the filtered data will then be the suspects that are the most probable cases of committing the crime on the said area.

The Geographic Crime Information Report will contain the result of the filtered data; it will also include a daily crime report and a weekly crime status report. The report can be exported in Excel and Word, one of the commonly used formats.

Figure 6. Geo Spatial Crime Visualization Flowchart



The parts of the Geo Spatial Crime Visualization are the Crime Management Module and the Geo Spatial Layering Sub Module. The Crime Management Module will assign coordinates on the map that will be given by the user using the Geo Spatial Layering sub module. The coordinates on the map will include and contain blotter data. The Geo Spatial Layering Sub Module will implement the framework and mapping system library by loading and displaying the map view from a shape file.

The parts of the Geographic Crime Information Analyzer are the Suspect Filtering Algorithm which innovates the use of the Haversine Formula and the Suspect Ranking Algorithm. The Suspect Filtering Algorithm works by comparing two points on the map. The Suspect Ranking Algorithm works by using the filtered points on the map and creates percentages on which of the following points are highly probable in committing the said crime.

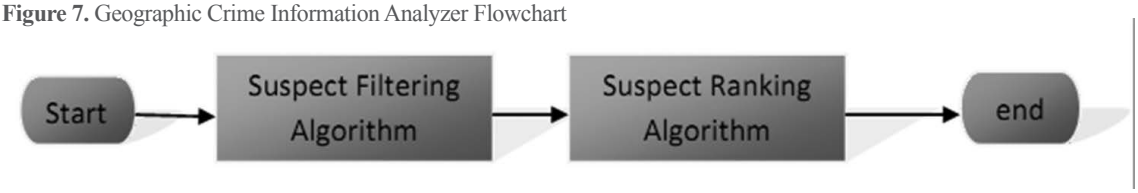
IV. RESEARCH OBJECTIVES

The primary goal of this study is the development of a Geographic Crime Information Reporting System at a Station Level in Mandaue City. The study intends to: (1) gather information from the Philippine National Police Station (Mandaue Headquarters); (2) design the crime database; (3) map the crimes into the Geographic Information System; (4) develop a geo-spatial visualization of crimes; (5) create an algorithm based on theories to narrow down the list of suspects; and (6) test and evaluate the developed system.

V. METHODOLOGY

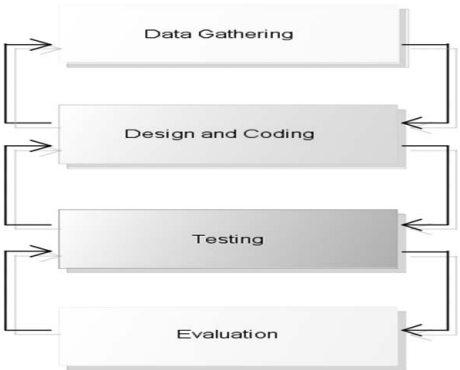
The modified waterfall method was used as

Figure 7. Geographic Crime Information Analyzer Flowchart



a software engineering paradigm for this project where the phases can overlap when needed (Munassar & Govardhan, 2010). The phases for this project are data gathering, design and coding, testing, evaluation.

Figure 8. Modified Waterfall Model for Research Methodology



Data Gathering. The Data is gathered by conducting series of interviews with PNP to learn about blotter gathering. The information on what to write in a blotter was requested and collected from the PNP. The map information, longitude, latitude, was gathered from Philippine GIS Data Clearinghouse. Literature review is conducted to learn more regarding image processing. The blotter information was gathered from various stations in Mandaue City.

Design and Coding. The system contains three components each with their own function. The Geo Spatial Visualization module contains other modules (Geo Spatial Layering module, and the Crime Management Module) using a mapping system library and framework. The Geo Spatial Layering Module will load and display the map view from a shape file. The Crime Management Module will assign a coordinate on the map given by the user. The Geographic Crime Information Analyzer Module will determine the list of possible suspects from the coordinates. A database is designed to store the coordinates and blotter information from the Crime Management Module.

The Geo Spatial Layering Module and the Crime Management Module are created by using GIS libraries from Philippine GIS Data Clearinghouse and C#. The Geographic Crime Information Analyzer module is created by analyzing the Rational Choice Theory, Crime Pattern Theory, and the Principle of Least Action. The Database is designed to store information from blotter information as well as the coordinates that was processed by the Crime Management Module.

Testing. A series of testing (unit testing, integration testing, system testing and acceptance testing) were conducted to ensure the quality of the study. Individual program function testing, function coordination testing, and system performance testing were conducted. Individual functions of the program were tested to check if it performs its expected function. Function coordination was tested to check if the functions were coordinated properly to the main function. System performance testing was conducted to check overall performance of the system.

Sampling Plan. Data provided from existing blotters were used as the medium for testing.

Evaluation Instrument. Two evaluation instruments were designed for the proposed system to be evaluated by PNP IT personnel and PNP officers. The survey formulated for PNP IT personnel is to test the systems' system process, and the survey formulated for PNP officers is to test the systems' system goals.

The PNP IT personnel evaluation instrument was developed using a 5-point scale where 1 is Not Acceptable, 2 is Slightly Acceptable, 3 is Moderately Acceptable, 4 is Very Acceptable, and 5 is Completely Acceptable, based on Henning's scale (2009). The scale is akin to saying that 1 is poor, 2 is Fair, 3 is Good, 4 is Very Good, and 5 is Excellent.

The PNP officer evaluation instrument was developed using a Yes/No scale for questions asking about e blotter and maps and pins and a 5 point scale for evaluating their usefulness. This

attempted to verify the usefulness of the proposed system.

The questionnaires for the evaluation stage for both PNP IT personnel and PNP officers were devised based on the readings and observations of suspect behavior and crime situations in Mandaue City. Some questions were made with the purpose of evaluating the importance of the developed system. The items were checked by to test its effectiveness and clarity to its respondents.

Statistical Tool and Treatment of Data. The PNP IT personnel were sampled purposively, specifically IT specialists from the PNP IT department. The survey questions were grouped based on the programs' functionality and usability. The survey results were averaged and interpreted where 1.00 to 1.80 means Not Acceptable, 1.81 to 2.60 means Slightly Acceptable, 2.61 to 3.40 means Moderately Acceptable, 3.41 to 4.20 means Very Acceptable, and 4.21 to 5.00 means Completely Acceptable.

The PNP IT personnel surveys used a 5-point rating system, where 5 is the highest possible rating. A mean rating of 1.00 to 1.80 is interpreted as not acceptable. A mean rating of 1.81 to 2.60 is interpreted as slightly acceptable. A mean rating of 2.61 to 3.40 is interpreted as moderately acceptable. A mean rating of 3.41 to 4.20 is interpreted as very acceptable. A mean rating of 4.21 to 5.00 is interpreted as completely acceptable.

There were 20 PNP officers surveyed through convenience sampling. Jaisingh (2006) suggested that a sample size less than 30 is a small sample. They were asked regarding on how acceptable the project was. Results were then tabulated in a matrix form.

$$weighted\ mean = {}^{raw\ score}/_{number\ of\ respondents}$$

By dividing the raw score (the number of points acquired in the 5-point scale) and the total number of respondents, we obtain the Mean. Mean and an acceptance test will be utilized for the analysis part.

Moreover, comments and suggestions were taken for both surveys to be used for descriptive analysis.

VI. ALGORITHM

The Geographic Crime Information Analyzer Module contains the Point Filtration Processing Module which innovates the use of the Haversine Formula. It performs a calculation to find the distance between two points on the earth's surface. The Haversine Formula is preferred than any other distance formulas because it calculates the distance between two points on a spherical plane. The Pythagorean theorem only calculates the distance on a flat plane. The maps that were used came from Philippine GIS. The maps in the program include the names of the barangay, names of the cities, and main roads. The Haversine performs the calculation from an aerial viewpoint. The earth's surface were not taken into consideration when using this formula. A map with point data on it is fed to the program.

The Haversine Formula:

$$CP_h = \left(1 - \cos {}^{(Ci_{la} - CI_{la})}/_2\right) + \left(\cos CI_{la} * \cos Ci_{la} * 1 - \cos {}^{(Ci_{lo} - CI_{lo})}/_2\right)$$

Where:

CP_h = Haversine distance between criminal incidences coordinates and crime incidence coordinates.

CI_{la} – Latitude of criminal incidence

CI_{lo} – Longitude of criminal incidence

Ci_{la} – Latitude of crime incidence

Ci_{la} – Longitude of crime incidence

With our given data, incidence were assigned point marks. The program determined the points given by the user from the radius. Values that

were less than the quantity assigned by the user. It situated the points that reside in the radius.

After filtering the data, it repeatedly performed the Haversine Formula on the set of points that have been filtered. The user then inputted the point of incidence on the map with a specific crime.

From there we then calculated for the distance between the incidence and the points close to it. The closer the points, the higher the chance that the person is the suspect. The result determined the most probable suspect.

The ranking of the possible suspects was determined by the formula; wherein the farther the point of incidence, the smaller the possibility/ percentage.

Given an incident location X (which contains coordinates from the database) and a search radius RAD in kilometers, we take the X1 (the first coordinate from the database) and calculate the Haversine Distance from the incidence. If the result is less than the RAD, it is an accepted value. The radius minus the current result will be the new result. The new result will be divided by the total number of similar crime committed by X, which will then be divided by the RAD. The result will give a decimal number and will be multiplied by 100 to get the percent value.

Point percentage Formula:

$$Cp(X, rad) = \left(\frac{rad - CP_h / \sum_{i=1}^{n} S_i}{rad} \right) * 100$$

$$\sum_{i=1}^{n} S_i = S_1 + S_2 + S_3 + \ldots + S_n$$

Where:

CP_h= Haversine Distance between criminal incidence coordinates and crime incidence coordinates.

X = suspect coordinates

RAD = radius estimate

Cp = point percentage value

S_n = the total number of crimes committed by X in station n.

Canter and Hodge (1997) suggests that serial murder will yield location data values of 0.81 miles and 0.79 miles; 0.77 miles for rape, 0.6 miles for arson, and 1.5 miles to 0.65 miles for burglary (Kocsis & Irwin, 1997). The values stated will be used for *RAD*.

Table 1. Geo Spatial Crime Visualization Module Testing

Case Scenario	***Expected outcome***	***Actual Outcome***	***Pass/Fail***
Load point data	Map loads	Map loads	Pass
Load shapefiles	Shapefiles load	Reprojection prompt, then files load	Pass
Load Background Picture	Load picture	Picture loads	Pass
Panning Map	Map moves with mouse hold and drag	Map moves with mouse hold and drag	Pass
Map Zoom In	Map Scales accordingly inward	Map scales with discernible distortion.	Pass
Map Zoom Out	Map scales accordingly outward	Map scales outward	Pass
Displaying individual point data	Displays all possible point when zooming in	Points display properly	Pass

VII. RESULTS AND DISCUSSION

System Testing. System testing was conducted to check the system's performance as a whole.

Table 1 shows that the Geo Spatial Crime Visualization Modules' loading maps, plot points as well as individual point data did not exhibit any problems. User errors regarding map zooming, and map panning point data were automatically corrected.

Table 2 shows that Geographic Crime Information Analyzer results do not exhibit any errors. User errors line calculations and results were automatically corrected.

Table 3 shows that the Geographic Crime Information Report Modules' Importing data to the database and Importing data to Word, Excel, and shape files did not show any problems. User errors regarding importing and exporting database data were automatically corrected.

PNP officer survey results. According to surveys conducted for PNP officers, 25% of them are not familiar with E-blotter. For those who knew the E-blotter, only 26.7% of them are using it. For maps and pins 85% are familiar with it, and 64.7% of them are currently using it.

Figure 9. PNP officer survey result for e-Blotter

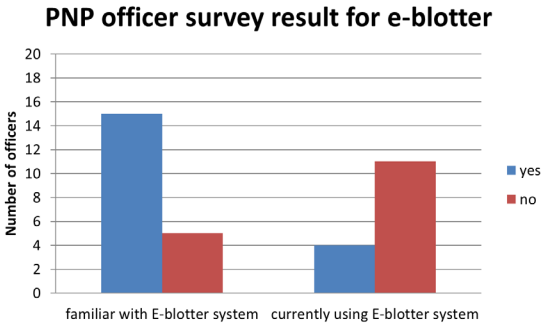


Table 2. Geographic Crime Information Analyzer Testing

Case Scenario	Expected Outcome	Actual Outcome	Pass/Fail
Testing values between June and July	21 results will display	21 results are displayed	Pass
Testing values of shoplifting	4 results will display	4 results are displayed	Pass
Testing values' status to be "At Large"	1 result will display	1 result is displayed	Pass
Drawing lines	1 line per calculated data	Each calculated has one line each	Pass

Table 3. Geographic Crime Information Report Testing

Case Scenario	Expected Outcome	Actual Outcome	Pass/Fail
Exporting data as shapefile	A shapefile and components are generated	A shapefile and components were generated	Pass
Exporting database to Excel	All database data will export	The data exported, with erroneous fields	Pass
Exporting database to Word	All database data will export	The data exported, with erroneous fields	Pass
Importing .csv file to database	File will import properly in the database	File imported with proper id.	Pass

Figure 10. PNP officer survey result for Maps and Pins

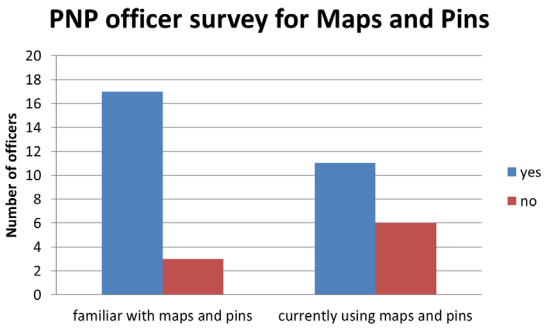
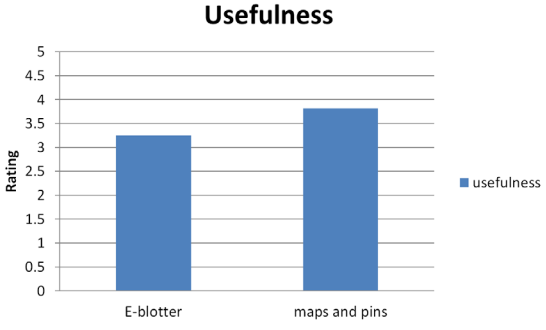


Table 5.2.1: 2 PNP officer survey: Usefulness table

	Raw score	$\overline{X}$	Acceptability
If Yes, Please rate its usefulness from 1 – 5, 5 being the highest and 1 being the lowest.	13	3.25	Moderately Acceptable
If YES, Please rate its usefulness from 1 – 5, 5 being the highest and 1 being the lowest.	41	3.82	Very Acceptable

According to the surveys the usefulness of E-blotter had a mean rating of 3.25, which is interpreted as moderately acceptable. The usefulness of maps and pins had a mean rating of 3.82, which is interpreted as very acceptable.

Figure 11. Usefulness



Based from the statistical results from the E-blotter survey result, the Maps and Pins Survey result, and the results from their usefulness - this shows that the proposed system is useful too.

Table 4. PNP officer survey: Importance table

	Raw Score	$\overline{X}$	Acceptability
The proposed system has an interface that is easy to understand; The Proposed system's understandability	79	3.95	Very Acceptable
The proposed system provides a time efficient decision making; The Proposed system's Time Efficiency	78	3.9	Very Acceptable
The proposed system implements the nearness theory and journey-to-crime theory effectively; The Proposed system's Theory Implementation	77	3.85	Very Acceptable
The proposed system creates accurate results of possible suspects; The Proposed system's Reliability	75	3.75	Very Acceptable

Based on the PNP Officers response, the systems importance had a mean rating of 3.8625, which is interpreted as very acceptable. The ease of understanding the system's interface was rated 3.95, which is interpreted as very acceptable. The system's provision of time efficient decision making was rated 3.9, which is interpreted as very acceptable. The system's implementation of the theories was rated 3.85, which is interpreted as very acceptable. The system's accuracy of results was rated 3.75, which is interpreted as very acceptable.

Figure 12. Importance of the proposed system

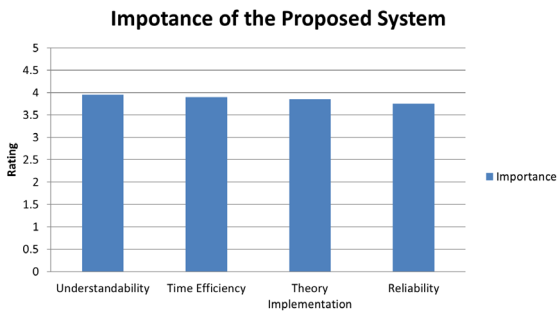


Table 5. PNP IT personnel survey: Functionality table result

Functionality	Raw score	$\bar{X}$	Acceptability
The image map of Cebu is accurate	23	4.6	Completely Acceptable
The image map of Cebu is up-to date	21	4.2	Very Acceptable
The proposed system provides proper landmarks	22	4.4	Completely Acceptable
The proposed system implements the proposed theories effectively	21	4.2	Very Acceptable
The simulation implements the algorithm accurately	23	4.6	Completely Acceptable
The proposed system creates accurate results of possible suspects	21	4.2	Very Acceptable
The proposed system creates an accurate filtration of narrowing down possible suspects	22	4.4	Completely Acceptable
The proposed system provides a time efficient decision making	21	4.2	Very Acceptable
OVERALL		4.35	Completely Acceptable

According to the surveys with the PNP IT personnel, functionality had a mean rating of 4.35. This is interpreted as completely acceptable. The accuracy of the systems maps had a mean rating of 4.6, which is interpreted as completely acceptable. Up to date maps of the system had a mean rating of 4.2, which is interpreted as very acceptable. The delivery of proper landmarks had a mean rating of 4.4, which is interpreted as completely acceptable. The effective implementation of theories had a mean rating of 4.2, which is interpreted as very acceptable. The accuracy of algorithm implementation had a mean rating of 4.2, which is interpreted as very acceptable. The accuracy of creating a list of possible suspects had a mean rating of 4.2, which is interpreted as very acceptable. The creation of accurate filtration of narrowing down possible suspects had a mean rating of 4.4, which is interpreted as completely acceptable. The time efficiency of decision making had a mean rating of 4.2, which is interpreted as very acceptable.

Figure 13. Functionality of the Proposed System

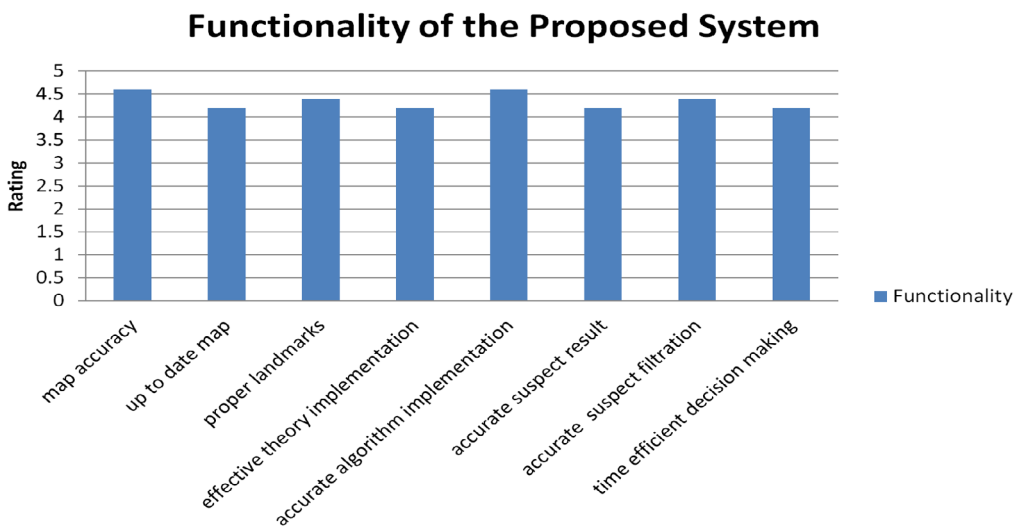


Table 6. PNP IT personnel survey: Usability table result

	Raw score	$\overline{X}$	Acceptability
The input area is free from error; The Proposed system's accuracy	19	3.8	Very Acceptable
The proposed system has a display that is easy to understand; The Proposed Systems understandability	20	4	Very Acceptable
The proposed system is user friendly; The Proposed system's reliability	21	4.2	Very Acceptable
The system provides instructions for use; The Proposed system provides instructions	19	3.8	Very Acceptable
All system components are working properly; The Proposed system's Functionality of components	20	4	Very Acceptable
The proposed system does not slow during runtime; The Proposed system's efficiency	18	3.6	Very Acceptable
OVERALL		4.68	Completely Acceptable

Usability according to the respondents had a mean rating of 4.68. This is interpreted as completely acceptable. The error free input area had a mean rating of 3.8, which is interpreted as very acceptable. The easy to understand display had a mean rating of 4, which is interpreted as very acceptable. The user friendliness had a mean rating of 4.2, which is interpreted as very acceptable. The provisions of instructions for use had a mean rating of 3.8, which is interpreted as very acceptable. The properly working system components had a mean rating of 4, which is interpreted as very acceptable. The constant running time of system had a mean rating of 3.6, which is interpreted as very acceptable.

Figure 14. Usability of the Proposed System

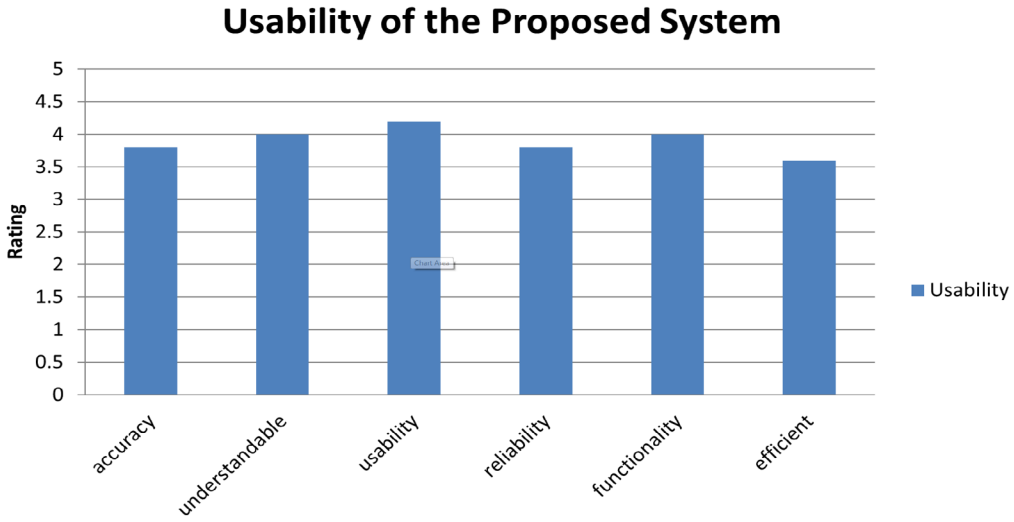


Table 7. PNP IT personnel survey: Overall result

	$\overline{x}$	Acceptability
Functionality	4.35	Completely Acceptable
Usability	4.68	Completely Acceptable
Overall	4.515	Completely Acceptable

Overall the system had a mean rating of 4.515, which is interpreted as completely acceptable.

VIII. CONCLUSION

The blotter information was stored in a database which contained the point coordinates where the crime is committed, suspect name, time when crime was committed, date, suspect description, station recorded, officer in charge, and a narrative description regarding the said crime.

Crime Information is mapped into the system with the use of shape files to be used for Geo Spatial Analysis. The map interface module was modeled successfully.

The mapping of crimes into the Geographic Information System was performed using the Geo Spatial Crime Visualization via the Crime Management Module and the Geo Spatial Layering Module. The Geo-Spatial Visualization of Crimes is capable of displaying of map layers and displaying the data on crime incidences.

The Algorithm for filtration of suspects was developed. The list of possible suspects is produced after analyzing given crime information by the user.

The output information of the Geographic Crime Information Report will be for the use and decision making of administrators. The system was tested and evaluated by Philippine National Police (PNP) officers and PNP Information Technology (IT) personnel.

Overall, the development of a Geographic Crime Information Reporting System at a Station Level in Mandaue City was successfully developed.

IX. RECOMMENDATIONS

Further interdisciplinary research with various fields should be conducted, such as the human ecology, operational, perceptual, behavioral, social psychological, legal, cultural, and geographic settings in its analysis (possible community based implementation), if one wishes to create an expert system.

The logbook containing the blotter information will be retained for operational purposes. For Large Scale Blotter Information, an Enterprise Database is recommended.

Originality Index:	97 %
Similarity Index:	3 %
Paper ID:	384318991
Grammarly:	Checked

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